Caloosahatchee Basin Aquifer Storage and Recovery Sensitivity. DRAFT (9/11/98)

Description of Simulations

A sensitivity analysis of the proposed Aquifer Storage and Recovery (ASR) system in the Caloosahatchee (C-43) Basin was completed using the South Florida Water Management Model (SFWMM). Model outputs from three simulation runs: 220-MGD Caloosahatchee ASR with 70% efficiency; no Caloosahatchee ASR; 220-MGD and Caloosahatchee ASR with 35% efficiency; were summarized and compared using the same set of performance measure graphics used in the Restudy. The first or reference model run corresponds to the Restudy "Alternative D13R" which was posted on the Restudy Hydrologic Performance Measures Web page on June 19, 1998. This alternative proposes an ASR wellfield with a total of 22, 10-MGD ASR wells (inflow and outflow capacities are the same). The other two model runs are scenarios derived from the first. Scenario 1 was simulated by having ASR injection and withdrawal capacities equal to zero MGD. The configuration and rules governing the operation of the Caloosahatchee ASR as simulated in **ALTD13R** was maintained in scenario 2 -- only the efficiency was changed from 70% to 35%. In the SFWMM, the Caloosahatchee ASR efficiencies are applied upon injection so that the size of the ASR "bubble" at the end of each time step truly represents the available storage in the ASR well. The intent or purpose of the Caloosahatchee ASR is defined in the description of Component D5 in the C&SF Comprehensive Review Study - Alternative D13R.

Assumptions

In both scenario runs, no operational adjustments or physical components were added or substituted to compensate for the reduction in efficiency or elimination of the Caloosahatchee ASR. The rest of the components incorporated in Alternative D13R are identical to the ones used in both scenario runs.

Summary of Results

Performance measure (PM) graphics comparing selected model output summaries are presented next. The reference run is designated as **ALTD13R**. Scenario 1 (without ASR) and scenario 2 (ASR with 35% efficiency) are designated as **NOCASR** and **35CASR**, respectively, in the attached graphics. Unless, otherwise noted, trends in either scenario run, e.g. increase in discharge or lowering of stages, are expressed relative to the reference run. The 1995 and 2050 base runs are plotted in all PM graphics for reference only. The major findings in this analysis are:

- The annual average injection rate from the reservoir into the ASR well for **ALTD13R** and **35CASR** are similar: approximately 98 kaf/yr with a 74%/26% wet/dry season split. The logic in the model does not reduce (or increase) injection of reservoir water into the ASR well as a function of ASR efficiency.

(note: Excess LOK water and C-43 basin runoff are pumped into the reservoir and not directly into the ASR well.)

- The components of the water budget for the Caloosahatchee reservoir in **35CASR** did not significantly change from **ALTD13R**. Outflow into the ASR well remained fairly constant (see preceding bullet). Water budget for **NOCASR**, however, shows a more significant change relative to **ALTD13R**. Reservoir water in **ALTD13R** that went to the ASR well (98.0 kaf/yr) was redirected in **NOCASR** primarily to: 1) Lake Okeechobee (54.1 kaf/yr or +35.4%), 2) C-43 basin (7.1 kaf/yr or +16%); and 3) C-43 estuary (4.5 kaf/yr or +11.0%). Losses due to evapotranspiration, seepage and spillover also increased for the without ASR scenario (7.6 kaf/yr or +5.7%). Excess basin runoff pumped into the reservoir decreased by 21.7 kaf/yr or -5.8% while LOK inflow decreased by 2.9 kaf/yr or -14.7%.

- The average annual supplemental irrigation demand for C-43 basin is 125.3 kaf/yr. Reduction in ASR efficiency by one-half, i.e., from 70% to 35%, resulted in a reduction of ASR contribution in meeting basin demand from 31.5 kaf/yr to 21.1 kaf/yr or about -33%. Mean annual deliveries from Lake Okeechobee (36.8 kaf/yr in **ALTD13R**) to C-43 basin increased by a factor of 1.25 (46.1 kaf/yr in **35CASR**) and 1.64 (60.5 kaf/yr in **NOCASR**). Mean annual contribution from the Caloosahatchee reservoir (43.5 kaf/yr in **ALTD13R**) to C-43 basin did not significantly change in **35CASR** but increased by a factor of 1.16 (50.6 kaf/yr) in **NOCASR**. Figure 1 shows C-43 basin demand-not-met of 2.6%, 3.6% and 3.1% for **ALTD13R**, **NOCASR** and **35CASR**, respectively. The reservoir-LOK configuration simulated in **ALTD13R**, given the same set of operating rules, is more effective, as far as meeting C-43 basin demand, than a reservoir-LOK configuration with a less efficient ASR system as simulated in **35CASR**.

- On an annual average basis, the Caloosahatchee ASR in **ALTD13R** released 16.0 kaf/yr to meet estuarine requirements. It decreased by 34.7% in **35CASR** and its contribution was zero in **NOCASR**. More significantly, both scenarios resulted in: a) four more months with low flow (<350 cfs) violations (top graph in Figure 2), and b) extended dry conditions in terms of maximum consecutive months with flows below 350 cfs (**ALTD13R**: 4 months and **NOCASR** or **35CASR**: 6 months at the bottom graph in Figure 2). Even with the decrease in performance due to the changes incorporated into the scenario runs, the number of low and high flow exceedances are still better than the recommended targets (Figures 2 and 3).

- Figure 4 shows the stage duration curve for Lake Okeechobee. (note: The **ALTD13R** line falls somewhere in between the lines describing the two scenario runs.) An increased withdrawal from LOK to meet basin demand (**ALTD13R**: 78.1 kaf/yr, **35CASR**: 87.5 kaf/yr, **NOCASR**: 105.1 kaf/yr) and satisfy estuarine requirements (**ALTD13R**: 22.7 kaf/yr, **35CASR**: 28.4 kaf/yr,

NOCASR: 33.9 kaf/yr) occurred. The stage duration curve corresponding to **35CASR** is slightly below **ALTD13R** which is consistent with the above trends in LOK water supply releases to the basin and estuary. However, the LOK stage duration curve for **NOCASR** is slightly above **ALTD13R**. This occurrence can be explained by an increase, from **ALTD13R** to **NOCASR**, in backpumping of excess Caloosahatchee runoff into LOK (**ALTD13R**: 153.0 kaf/yr, **35CASR**: 151.7 kaf/yr **NOCASR**: 207.1 kaf/yr) which more than offset the increase in LOK release to meet downstream (C-43 basin and estuary) needs. The slight increase in LOK storage from **ALTD13R** to **NOCASR** could have translated into better C-43 basin and C-43 estuary performance (refer to Figures 1 and 2, respectively) if a correponding adjustment in operating rules in conjunction with the removal of the Caloosahatchee ASR had been in place. As mentioned in the first bullet above, the amount of reservoir water injected into the ASR is not a function of the ASR efficiency. More excess water in the C-43 basin can be diverted into LOK (via the reservoir) if there were no ASR but not with a less efficient ASR.

- The trends observed in Figure 4 are consistent with those in Figure 5 which shows a slight decrease (for **35CASR**) and a slight increase (for **NOCASR**) in the total volume of lake regulatory discharges.

- The performance of the St. Lucie (C-44) Basin changed marginally due primarily to the slight decrease (**35CASR**) and slight increase (**NOCASR**) in LOK stages. The C-44 basin supplemental irrigation demand is 27.7 kaf/yr. Demand-not-met for the three runs are **ALTD13R**: 6.7%, **35CASR**: 6.8%, and **NOCASR**: 5.2% (Figure 6). No apparent change in the St. Lucie estuary performance measures was observed for both scenario runs.

- The Everglades Agricultural Area (EAA) did not experience a significant change in its performance in terms of mean annual supplemental irrigation and demand-not-met during the entire simulation period (Figure 7a) or during the drought years (1971, 1975, 1981, 1985 and 1989) (Figure 7b). The top-right graphs in Figures 7a and 7b show the additional dependence on lake water due to the removal and reduction in efficiency of the Caloosahatchee ASR. (note: The legend "DMD met by RES" denotes the combined water supply deliveries from a reservoir and an ASR, if any.) On an annual average basis over the entire simulation period, the lake water supply deliveries to the other, i.e. non-EAA, Lake Okeechobee Service Areas (LOSAs) increased by 9.0 kaf/yr (or +5.0%) and 24.0 kaf/yr (or +13.4%) for **35CASR** and **NOCASR**, respectively (Figure 7a). (note: The combined C-43 and C-44 basin supplemental irrigation requirement accounts for slightly more than one-half the total requirement for the other LOSAs.)

Fig. 1 C43 Basin Regional Irrigation Supply and Demand Not Met

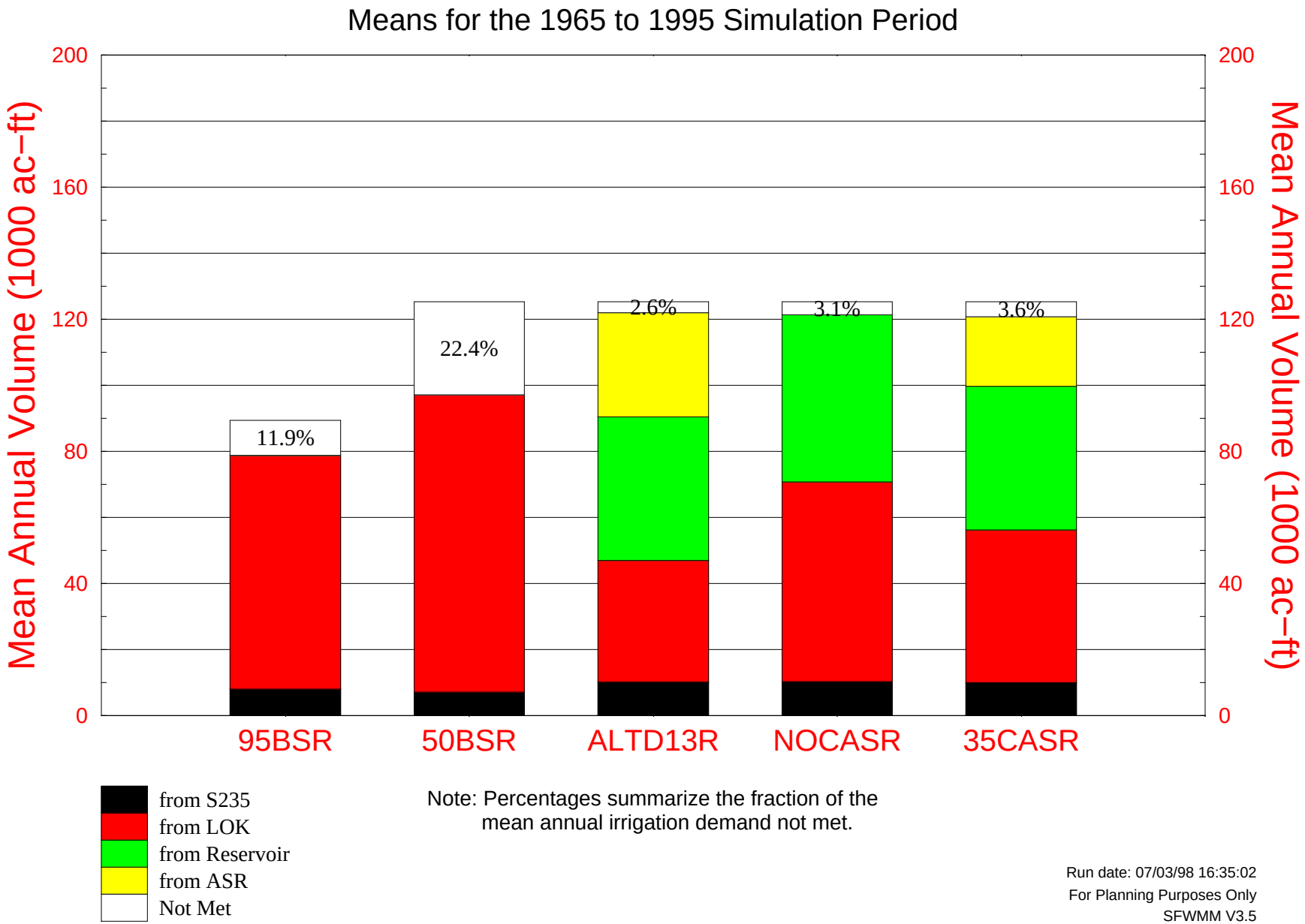

Fig. 2 Number of Times Salinity Envelope Criteria were NOT Met for the Calooshatchee Estuary (mean monthly flows 1965 − 1995)

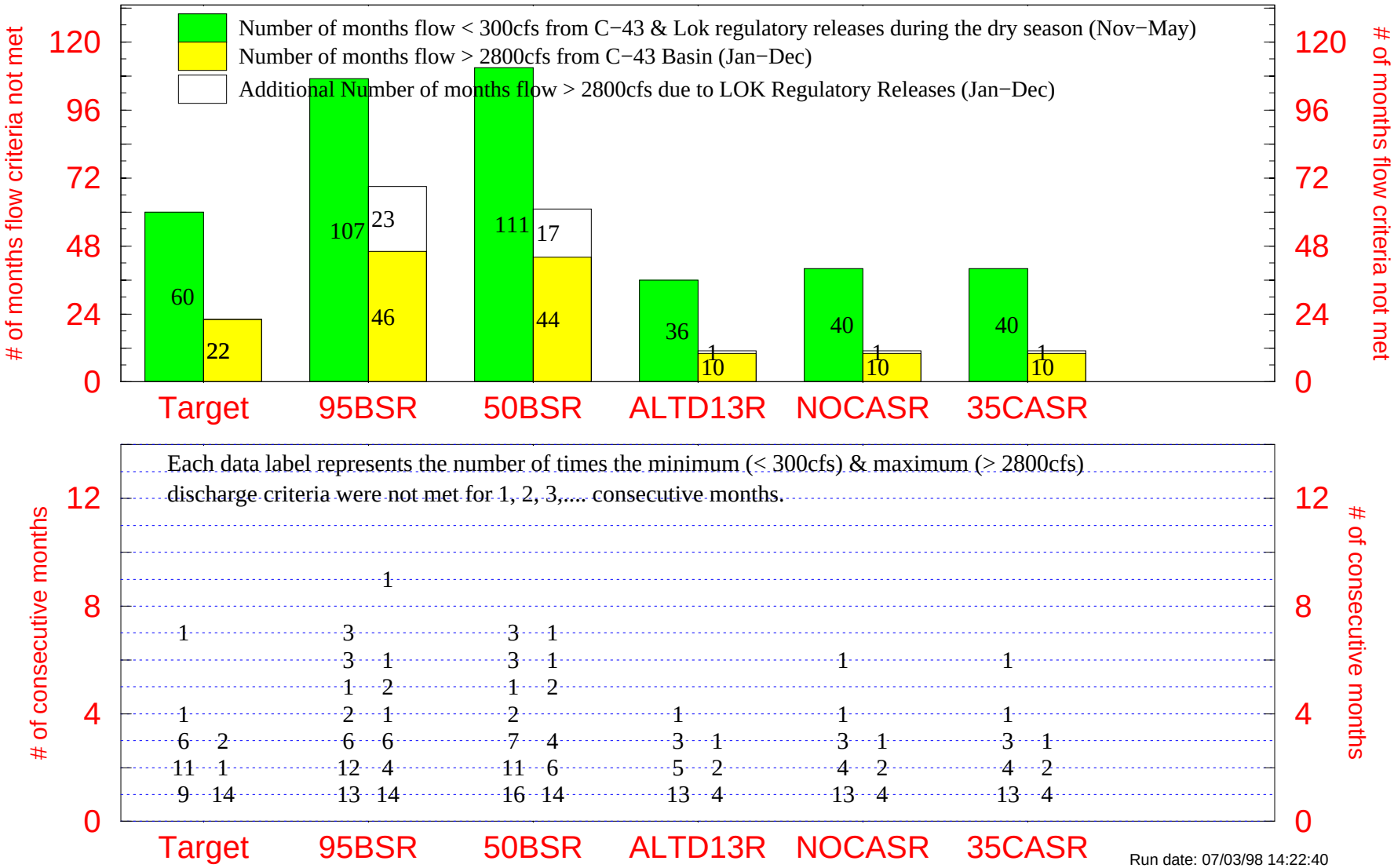

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Fig. 3 Number of Times High Discharge Criteria (mean monthly flows > 2800 & 4500 cfs) were exceeded for the Caloosahatchee Estuary

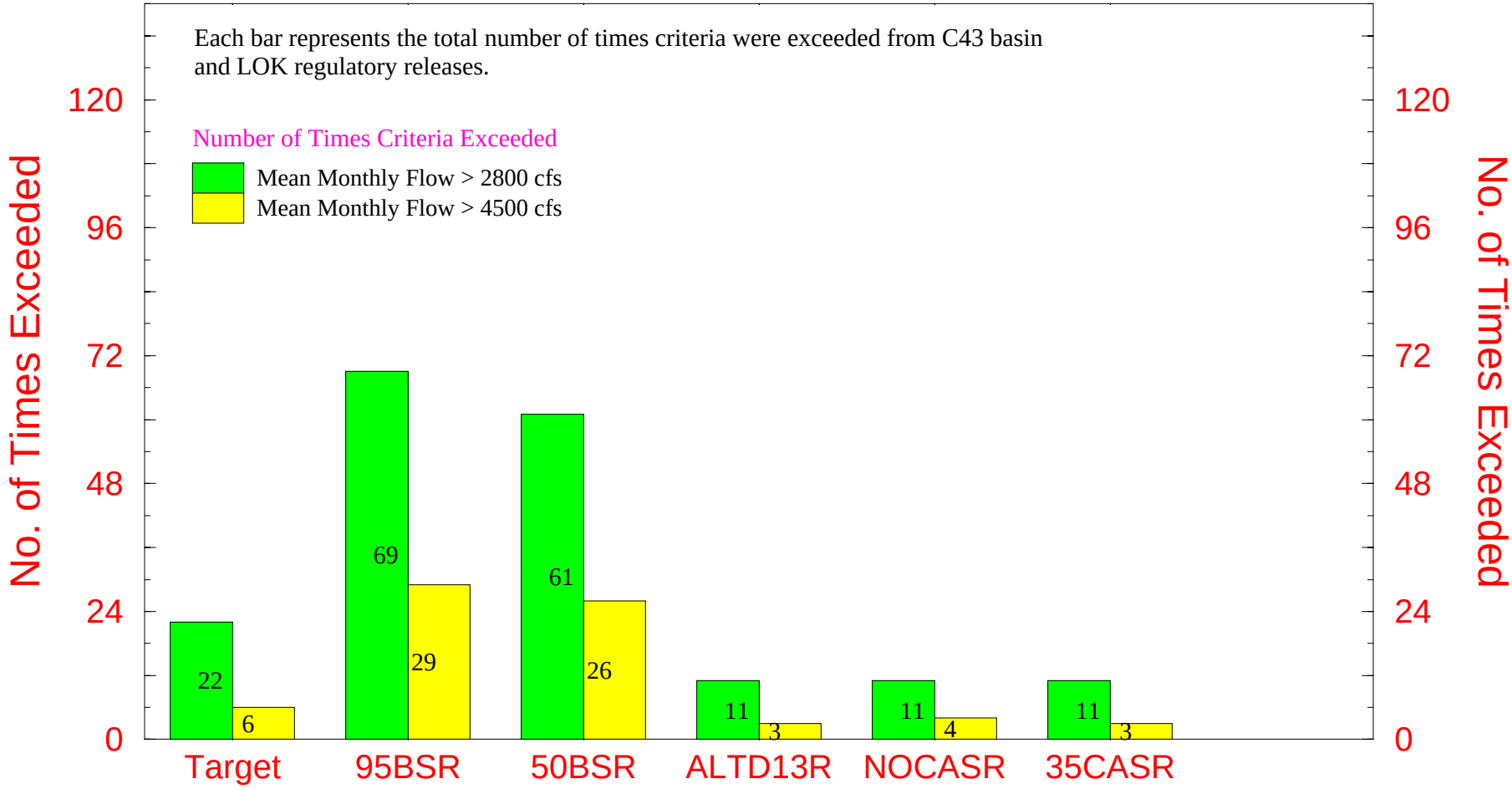

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Fig. 4 Lake Okeechobee Stage Duration Curves

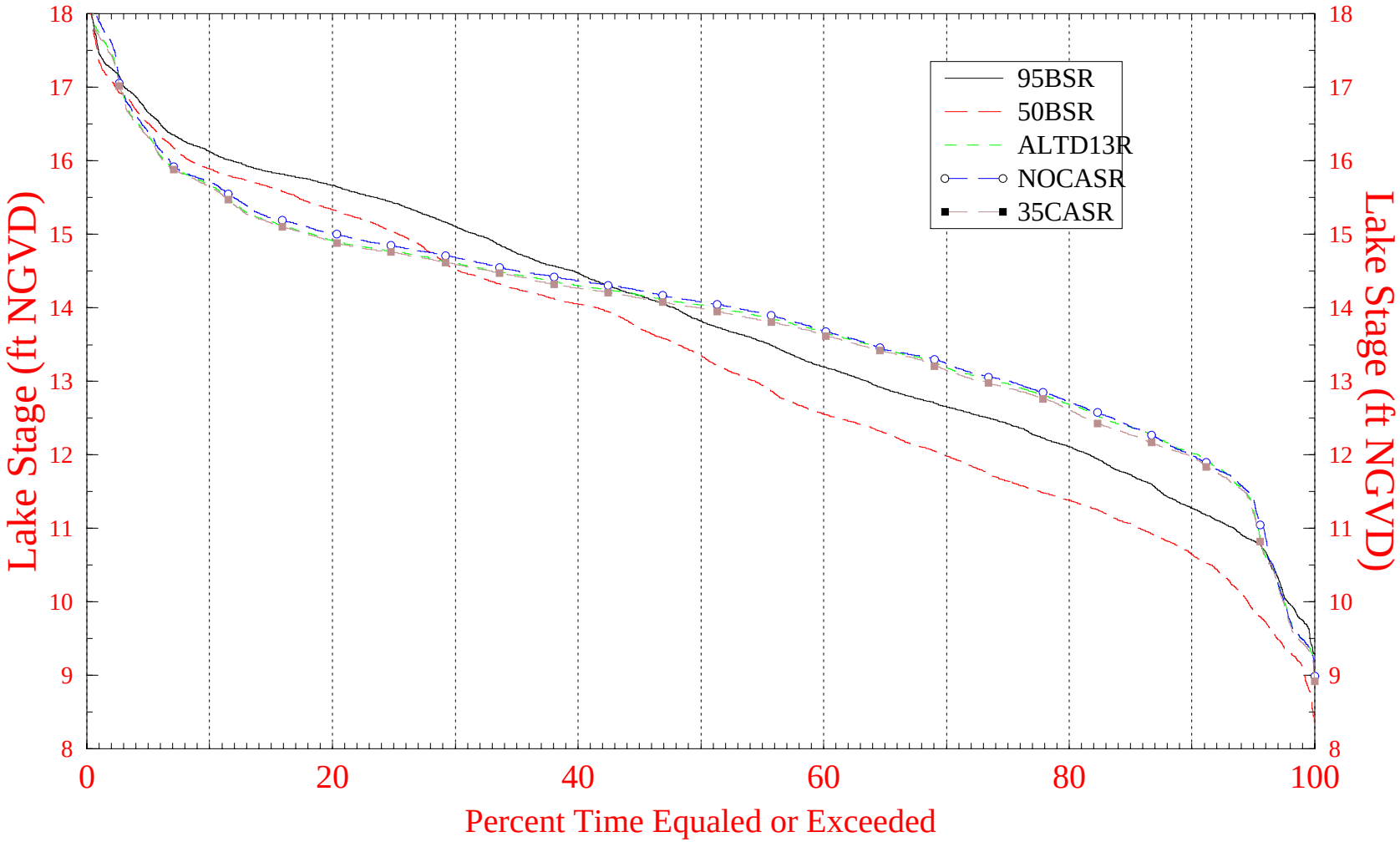

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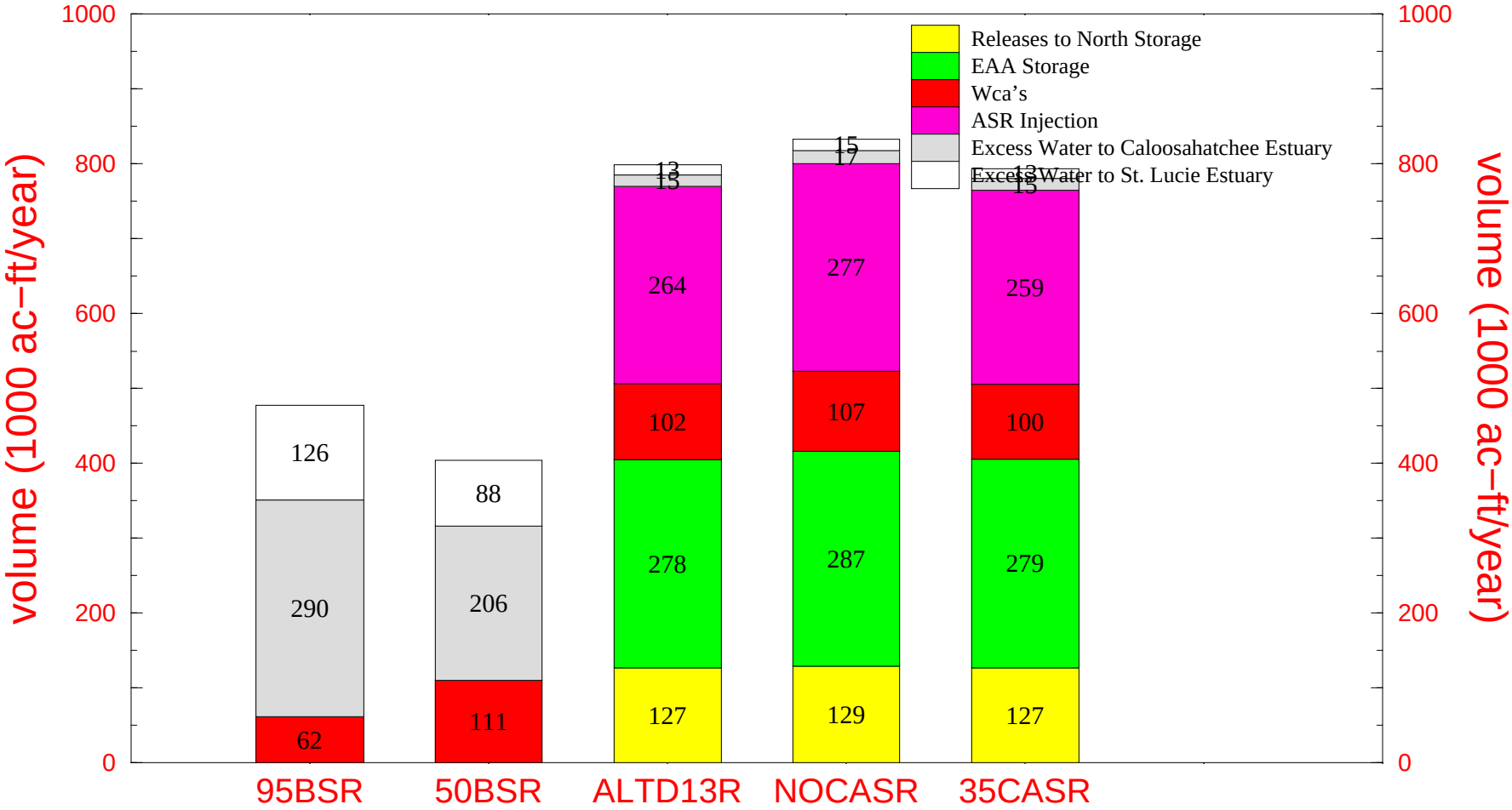
Fig. 5 Mean Annual Flood Control Releases from Lake Okeechobee for the 31 yr (1965 − 1995) Simulation



Note: Although regulatory (flood control) discharges are summarized here in mean annual values, they do not occur every year. Typically they occur in 2−4 consecutive years and may not occur for up to 7 consecutive years.

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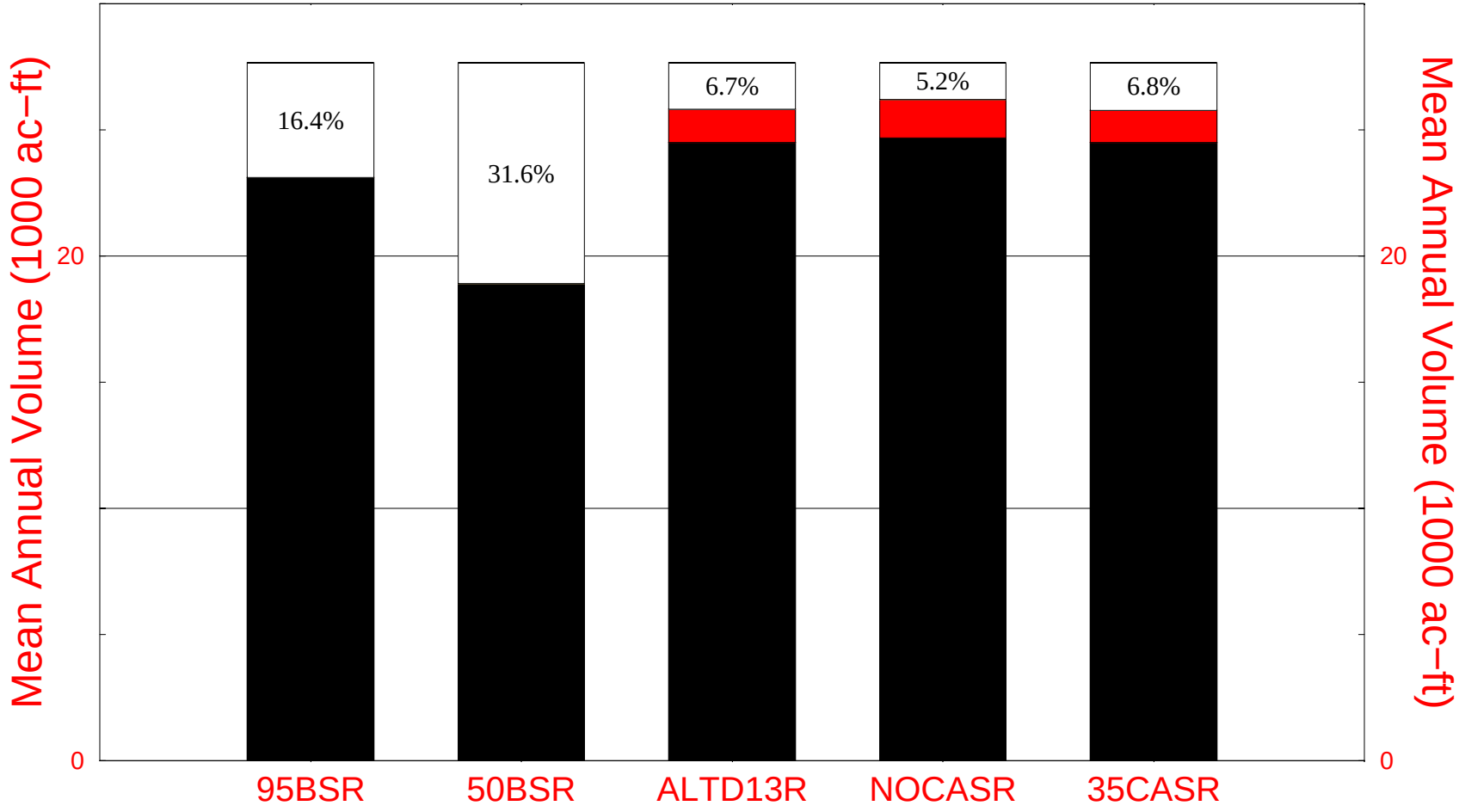
Fig. 6 C44 Basin Regional Irrigation Supply and Demand Not Met

Means for the 1965 to 1995 Simulation Period



Note: Percentages summarize the fraction of the mean annual irrigation demand not met.

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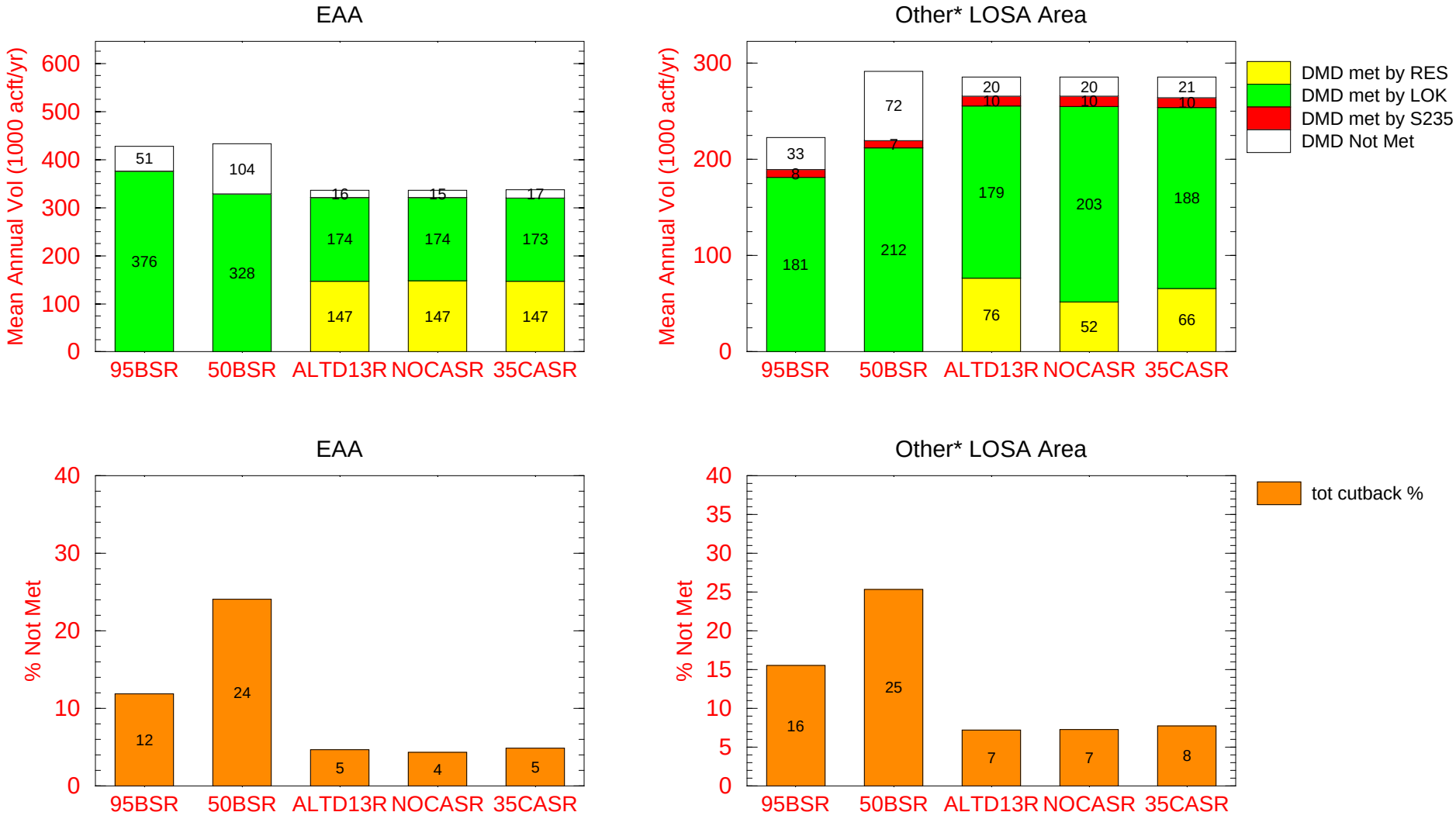
Fig. 7a Mean Annual EAA/LOSA Supplemental Irrigation: Demands and Demands Not Met

for the 1965 − 1995 Simulation Period



*Other Lake Service SubAreas (S236, S4, L8, C43, C44, and Seminole Indians (Brighton & Big Cypress)).

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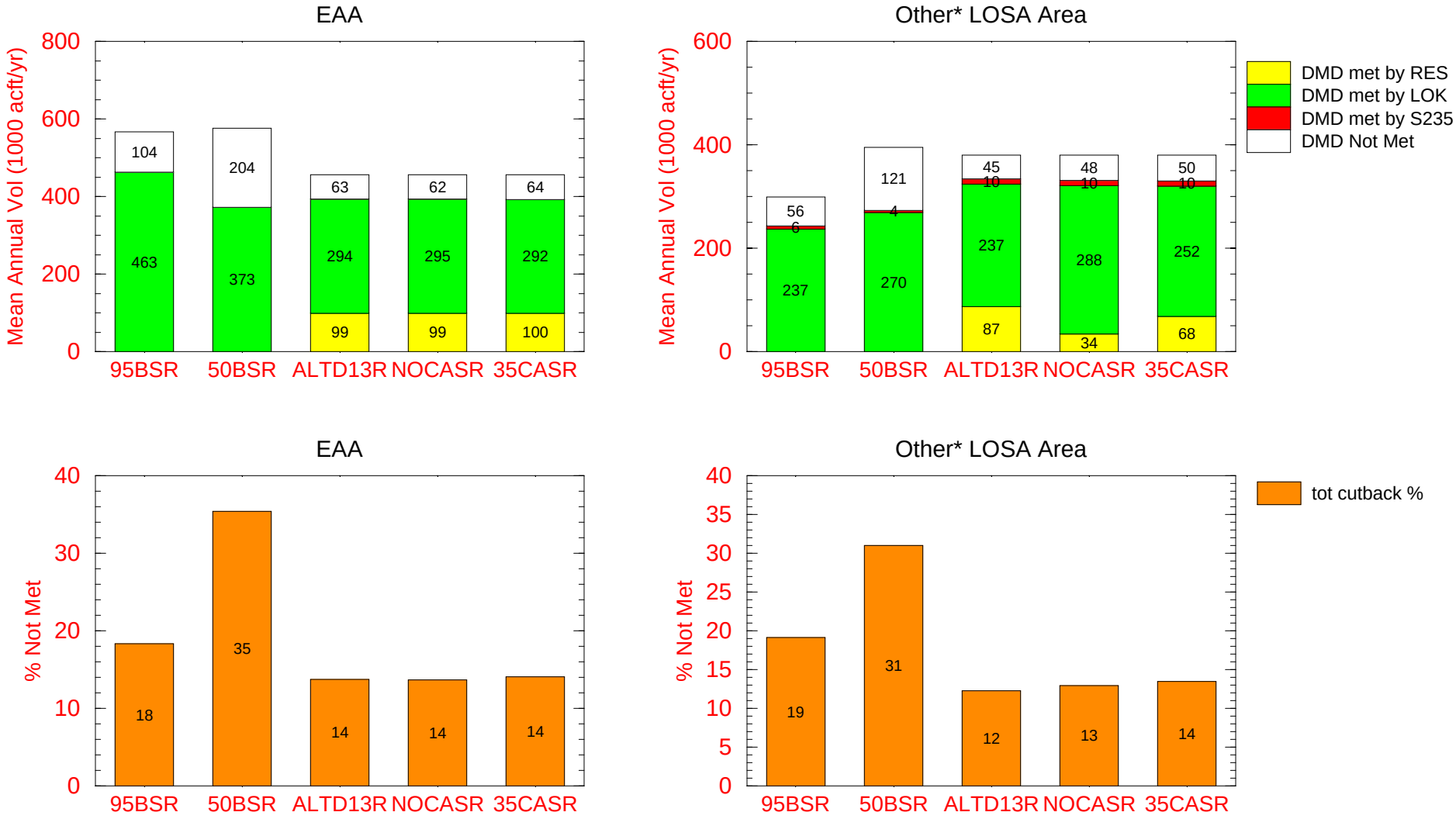
Fig. 7b Mean Annual EAA/LOSA Supplemental Irrigation:

Demands and Demands Not Met for the Drought Years:

1971, 1975, 1981, 1985, 1989 within the 1965 − 1995 Simulation Period



*Other Lake Service SubAreas (S236, S4, L8, C43, C44, and Seminole Indians (Brighton & Big Cypress)).

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